supply is sufficient to meet cable and node requirements (3 phase, 480-volt, 10kW).

Submarine Cable Route Alternatives

The selected ocean cable route as presented in Figure 1 is the preferred cable route. An alternate route for the MARS cable installation was investigated, but several serious problems were encountered that led to this option being abandoned. The alternate route did not meet all required science needs, the water depth was not sufficient for a deep water test bed node, and installation would have been more difficult than for the northern route due to rock outcrops.

This route cannot reach a location on the western side of the San Gregorian Fault line without crossing the canyon. Experience has shown that equipment or cables placed in the canyon at this location would likely survive less than a year before being destroyed by mass wasting events. One of the scientific aims of the MARS project is to connect to a permanent broadband seismometer located west of the San Gregorian fault line to complement the land-based network of broadband seismic stations. This is crucial to 1) provide better azimuthal coverage and thereby improve the characterization of moderate to large earthquakes occurring in northern California along the San Andreas system, and 2) to improve knowledge of the deep structure of this plate boundary. Also, experience in long-term deployment of broadband systems is crucial for the successful development of long-term global seismic sea floor observatories as advocated by the International Ocean Network.

The MARS observatory is a test bed for a deep-water cabled observatory, and many of the components and systems to be tested need to be located at a deep water site. The depth of the old alternate node is only 130 meters, and the engineering systems need water depths closer to 1,000 meters. Only the currently proposed route provides access to water with a depth suitable for the engineering tests.

There are no active seeps or chemosynthetic biological communities (CBCs) close to the alternative route node location. These are important study sites that, if connected to a cabled observatory, enable important long-term data to be collected on these benthic communities. Imaging systems and sensors deployed on a cabled observatory would document the behavior of individuals (e.g., clams), the dynamics of populations, and variation in the structure of seep and vent communities. Concurrent monitoring of fluid chemistry and other environmental factors (e.g., current speed), coupled with measurements of the response of the community to experimental manipulation of fluid chemistry, could help define the roles of intrinsic environmental (e.g., fluid chemistry) and biological factors versus external processes (i.e., effects of ocean currents on larval transport). Of the MARS routes investigated, only the currently proposed site provides a node location close to known CBCs and active seeps.

Finally, studies have shown that there are many large rock outcrops on the edge of the continental shelf that would be problematic for cable laying.

2 Project Purpose and Overview

The goal of this project is to design and install an advanced cabled observatory in Monterey Bay that will provide a continuous monitoring presence in the Monterey Bay National Marine Sanctuary, as well as serve as the test bed for a state-of-the-art regional ocean observatory, currently one component of the National Science Foundation (NSF) Ocean Observatories Initiative (OOI). The test bed will provide real time communication and continuous power to suites of scientific instruments enabling monitoring of biologically sensitive benthic sites and to allow innovative scientific experiments to be performed.

The Monterey Bay Aquarium Research Institute, along with the University of Washington, Jet Propulsion Laboratory, and Woods Hole Oceanographic Institution have received a grant from NSF to design and install the cabled observatory in Monterey Bay. This observatory, the Monterey Accelerated Research System (MARS), will consist of an undersea cable and node that will provide power and high-speed data links for a variety of oceanographic devices.

MBARI's close relationship with the Monterey Bay Aquarium places it in a unique position to employ MARS as an educational tool for the public. The Monterey Bay Aquarium is one of the world's leading organizations devoted to teaching the public about the ocean. MBARI will bring MARS science and technology to the public through the Aquarium's world-class facility, drawing on the expertise of the MBA's staff of 420 employees and 900 volunteers.

Enhancing resource protection and preserving the natural beauty and bounty of the marine ecosystems within its boundaries is the purpose of the Monterey Bay National Marine Sanctuary. This can be accomplished by improving the understanding of the Sanctuary environment, resources, and qualities. The results of research conducted utilizing MARS can be used to make management decisions about resource protection, to develop and improve educational programs, and to help MBNMS, and similar agencies, fulfill their missions.

By supplying both data links and electrical power, this network will allow real-time, continuous, and long-term monitoring of conditions beneath the surface of the bay. Currently such information can only be gathered during intermittent ship cruises or using temporary devices that must eventually be retrieved when their batteries are depleted.

MARS will be located in Monterey Bay offshore MBARI. It will consist of 51 kilometers of submarine cable and a science node located approximately 891 meters below the ocean surface. The node will have eight separate science ports (docking stations) for oceanographic instruments. Each port will support bi-directional data transfers of up to 100 Mbits per second. The cable and node will have the ability to supply up to 10 kilowatts of power to the instruments; much more power than could be supplied using batteries alone. (See Appendix D for examples of instrumentation.)

The system will make use of the tools, techniques, and products developed over the last several decades for high reliability submarine telecommunication and military systems to ensure that this system can operate over a 25-year lifetime.

Within the MARS team, Woods Hole Oceanographic Institution is developing the communications and command/control systems. The University of Washington and Jet Propulsion Laboratory are working on the power supply system. A private company, Alcatel, will be overseeing the actual construction and installation of the cable wet plant.

MBARI will provide the shore base for the network and will be involved in project management and engineering, including the permitting and environmental review process. This last element is critical to make sure the cable does not damage fragile marine ecosystems within the Monterey Bay National Marine Sanctuary. MBARI will also team up with the Monterey Bay Aquarium to make scientific results from the MARS project available to students and the general public.

In addition to supporting oceanographic research within Monterey Bay, MARS will serve as a testing ground for technologies to be used in more ambitious undersea networks, such as the NEPTUNE project (http://www.neptune.washington.edu).

The broader implication of installing MARS is that the oceanographic community will be a giant step closer to providing real-time, continuous access to unprecedented power and communications capability underwater on a regional scale. This type of ocean observatory will revolutionize the way researchers study the ocean and the seafloor beneath. Benefits will include more cost-effective collection of much larger amounts of integrated, multidisciplinary data relevant to important scientific and societal issues, such as natural hazards, the climate system, the carbon cycle, and other biologically mediated processes in the ocean. In addition, researchers will use such facilities to explore entirely new classes of problems currently unapproachable with existing methods and instrumentation.

MBARI is planning to contract with Alcatel to install the cable. Alcatel is currently processing data from the recent route survey (see Fugro 2004) to devise a work plan for MARS. This information can be provided as soon as it becomes available. Construction is planned for summer 2005, dependent on permitting.

3 MARS Installation Procedures

The MARS system consists of a single submarine cable between a shore station in Moss Landing and a node to be placed on the seabed at the end of the cable on Smooth Ridge. The estimated length of the cable is 51 kilometers. A target burial depth of 1.0 meter by plow is proposed, subject to suitable seabed conditions. As the maximum water depth is expected to be 891 meters, burial is proposed throughout the whole route, where burial is possible with the plow.

3.1 Pre-Lay Grapnel Run (PLGR)

Prior to the main lay operation, a pre-lay grapnel run (PLGR) will be carried out by the main lay vessel along the proposed cable route. The PLGR operation will be to industry standards employing towed grapnels. The intention is to attempt clearance of any seabed debris, for example wires or hawsers, fishing equipment etc. that may have been deposited along the route. Any debris recovered during these operations would be discharged ashore on completion of the operations.

The operation involves the towing of one or an array of grapnels along the length of the route to be plowed. The vessel proceeds at a rate to ensure that the grapnel(s) maintain continuous contact with the seabed. The grapnel is usually a 'sliding prong' type, which can penetrate up to 40 centimeters into the seabed. The grapnel is connected to the towrope or wire by means of a length of 30 meters of chain with a similar length of chain following the grapnel; the chain further assists in keeping the grapnel in contact with the seabed.

As the vessel moves along the route, the towing tension is monitored and the grapnel(s) is recovered if the tension increases indicating that an obstruction has been hooked. As a matter of routine, the grapnels are recovered and inspected at minimum intervals of 15 kilometers along the route. Usually a single tow is made along the route but in areas where other marine activity or debris amounts are high, additional runs may be made.

3.2 Main Lay Operations

The proposals for the main lay operation is to directly land the cable at the shore end and to plow bury the cable.

The plow is hydraulically operated and is towed by a towrope from the cable installation vessel. The cutting depth of the plow is controlled by varying the position of the skids and the angle of the plow share. Rear stabilizers can be used to assist with depth control on soft ground. The plow is fully remote controlled from a control cabin onboard the vessel, while being towed. The plow is equipped with vertical and lateral cable angle sensor and visually by means of a forward TV camera.

Plow burial will be made along the route sections recommended by the survey and BAS, subject to seabed conditions.

3.3 Plowing Operations

When plowing, cable is laid to achieve a touch down just in front of the plow as described below:

The plow will be deployed and recovered by means of the ‘A’ frame located at the stern of the vessel. A ‘docking frame’ assembly is used to minimize any excessive pendulum motion caused by vessel movement when the plow is being handled out of the water.

The plow will be launched by lifting it from the working deck and moving the ‘A’ frame slowly outboard until the plow is clear of the stern; pay out will be continued until the plow is a few meters below the surface of the sea. At this stage the plow systems will be checked prior to transferring the weight of the plow to the towline and carefully lowering the plow to the seabed. As the plow is lowered the plow control umbilical with attached recovery line will be simultaneously paid out.

When the plow arrives at the seabed, the laying vessel moves slowly forward paying out cable to maintain tension, and adjustments are made to the tow wire and umbilical line to achieve the optimum towing scope or ‘layback’ for the plow. While these adjustments are made the plow remains stationary. Just prior to the start of plowing the tow winch rendering is set to avoid excessive towing tensions.

As the plow starts to move, the plow skids will be raised (causing the share to dig deeper into the seabed) and the depressor arm is lowered until the required burial depth is achieved. Cable will be paid out such that the cable reaches the seabed a few meters in front of the plow. This results in minimal residual cable tension measured at the plow.

When the end of the plowed section is reached, the skids are lowered and the depressor arm is raised causing the burial depth to be reduced to a minimum. The lay vessel is stopped and the towing scope is reduced while simultaneously recovering the umbilical and attached recovery line. When the plow lifts clear of the seabed, the lay vessel will move ahead very slowly as the plow is raised to the surface. Lay cable is paid out to maintain appropriate tension. The plow will be held at a point just below the surface while the recovery line is attached to the lift wire, which passes over a sheave at the top of the 'A' frame. The plow is then raised on the recovery/lift line to engage in the docking frame. Finally the 'A' frame is moved inboard, and the plow is lowered to the vessel's deck.

3.4 Trawl Resistant Node Frame Deployment

The cable will be installed from the sea towards the shore landing. It is anticipated that the cable will be plow buried throughout most of the cable route and that as the main lay vessel approaches the node installation point (approx. two times the water depth or two kilometers away), the plow will be recovered. It will then surface lay the cable and deploy the trawl resistant node frame on the end of a ground rope and continue surface laying the ground rope. When the trawl resistant node frame is on the seabed, an acoustic release will be activated which will part the ground rope just above the seabed leaving approximately two kilometers of ground rope attached to the node. This two-kilometer section of ground rope would then be recovered using the on-board ROV and a cutting tool and attaching a recovery rope to the ground rope.

The two-kilometer surface laid section of cable would be post-lay buried by jetting.

After the cable and the trawl resistant node frame have been deployed, MBARI's R/V *Point Lobos* will lower the MARS node onto the ocean floor near to the trawl resistant node frame. ROV *Ventana* will then latch onto the trawl resistant node frame, lift it, and then lower it into the trawl resistant node frame. The ROV will then attach the underwater mateable connectors between the node and the trawl resistant node frame to allow the node electronics to be connected to the shore through the cable.

3.5 Post-Lay Inspection & Burial (PLIB)

Post lay inspection and burial will be conducted by MBARI's ROV Ventana. This will include the following :

- Initial, final, and intermediate splice positions in the buried sections
- Burial in the plowed sections (where plow did not bury for operational reasons (i.e. soft conditions, steep slopes, etc.)
- Cable and pipeline crossings
- Any unburied sections required as part of the node deployment operation

In order to minimize the risk to the exposed cable, the PLB program will be designed, wherever possible, to closely follow that of the main lay vessel program.

The proposals for PLB assume jetting into suitable seabed materials. Rock cutting, trenching, or similar is not proposed.

All post lay burial work will be inspected with an allowance for overlaps into adjacent plowed sections.

An ROV capable of 1.0-meter burial and ability to operate in water depths in excess of 1,000 meters will be used. The ROV will be free flying, or tracked, and fitted with lights, cameras, depth sensor, pitch and roll sensor, heading sensor, and other appropriate fittings required to perform the work.

Alcatel intend to use Makai software during cable installation operations. This sophisticated system is able to model the catenary of the cable and predict the required cable slack, thereby minimizing the risk of installing loops in the cable system.

Horizontal Directional Drill (HDD) Procedures for Shore Landing

Alternative 1 - MBARI Property to Offshore. The HDD procedures for Alternative 1 for the MBARI property to offshore include an estimated bore length of 4,700 feet (1,432 m) that would be installed an estimated depth of 90 feet (27 m) to 100 feet (30 m) below sea level. An onshore drilling crew, marine support crew, and construction monitors will support the HDD procedures. The onshore drilling crew will operate the drill rig, mud system (i.e. drilling fluid to lubricate the drill bit), and support equipment. The marine crew will guide and verify the drill path, and adjust the drill path if necessary. During the drilling procedure, the drill path will be constantly monitored for surface releases of drilling mud, and constant communication will occur between the monitoring vessel and the control cab during the entire HDD procedure.

The entry and exit points will be established, and relative elevations and drill distances surveyed in and verified. During this operation, any existing sub–surface obstructions in the area will be identified and staked. A sub-bottom profile of the ocean floor will be done to verify the depths provided are correct so as to establish a true running line and elevation for the drill path. The marine support crew will set a buoy at the exit coordinate provided by the client, and this distance will also be measured and verified. The drill path might need to be adjusted slightly should any conflict with an existing utility be encountered. The anticipated depth (90 to 100 feet) should be deep enough to hinder the release of drilling mud to the surface and stay above the unknown formations below based upon information gather to establish the geologic setting. Where possible a locating grid will be surveyed in along the entry portion of the drill path and a thin 8 ga. wire laid out on the perimeter. While drilling, a small DC current will be induced into the wire to create a magnetic field with known corner points that can be picked up by the sensor in the steering tool. This grid is used to verify the locational readings transmitted to the control cab continuously through a wire in the drill stem. The steering tool, located behind the drill bit, keeps track of the azimuth and the inclination, giving the surveyor an accurate location of the bit at all times.

The staging area for the directional drill would be located on the south side of the entry channel on MBARI property (Assessor Parcel Number 133-252-001). A site 100 feet by 150 feet will be used to set up the equipment; drill rig, mud system, extra drill pipe, support vehicles, and enclose the entry pit.

Site preparation will require the construction of a concrete pad (10 ft by 6 ft by 4 ft) that will be used to anchor the drill rig during the HDD procedures. Prior to placing the drill rig on the concrete pad, plastic barriers will be placed under the drilling equipment and oil absorbent blankets around hydraulic components will ensure protection between the drill rig and ground surface if a spill were to occur.

The bore entry point will be established by excavating a small sump pit that will be used for the recovery of the drilling fluid coming from the borehole back to the surface. The fluid will be picked up by a sump pump and transferred to a solids control unit where the solids contained in the drilling fluid will be mechanically separated allowing the mud to be recirculated down the bore hole for use again. Once all the equipment is in place, silt fences and hay bales will in place around the work perimeter, the sump pit, and mud recovery system.

When the drilling rig is in place and all the environmental measures have been implemented, drilling will begin. As the HDD proceeds along the pre-determined route drilling fluid is pumped down the inside of the bore pipe and exits through the drill head. The fluid then returns to the entry pit through the annulus between the outside of the drill pipe and the formation being bored. The drilling fluid is composed of naturally occurring bentonite clay and water. The clay is insoluble and made up of small particles that function as a lubricant for the drill head and pipe, a transport for the cuttings being removed from the hole, and as a sealant that fills the annulus space surrounding the drill hole.

As the drill stem approaches the exit point on the ocean floor, the drilling conditions will be monitored to determine the time or distance from exit when a shift from the bentonite to fresh water drilling will be done. By flushing the drill string with fresh water, the drilling mud is circulated out of the system and a mud free exit is achieved. The shift from bentonite to fresh water is determined by the soil conditions near exit point. As general rule of thumb, 150 feet is the average distance at which a change to fresh water happens. Once the drill exits the sea floor the marine support crew will be dispatched to dive on the exit and verify the exit point. Once the exit has been verified, the on-site inspector will be given the offshore exit coordinate to approve. The approval must not be delayed, as the drill string will need to be withdrawn as quickly as possible to avoid getting stuck in the hole.

Once the exit has been approved, divers will jet down approximately 2 feet below the sea floor and use underwater cutting equipment to cut off the drill steel at the desired depth. Once the pipe is cut and the end of the pipe has been de-burred to remove any sharp edges, the guidance wire will be removed and a pipe pig will be installed at entry with a ¼” cable attached. The pipe pig will be hydraulically pushed through the drill pipe with fresh water and the ¼” cable trails the pig. The pig proofs the pipe as well as verifies a clean I.D.

Once the HDD procedure is complete, the temporary pull-line installed, and the pipe is capped and back-filled, the drill crew will de-mobilized. The de-mobilization involves removing all excess drilling fluid from the sump pit and disposed of at an appropriate site. The plastic barriers and oil absorbent cloth will be removed and disposed of appropriately including the silt fence and hay bales. The concrete pad used to anchor the drill rig will be broken up and removed from the site and any excavation back-filled, and the work area will be returned to its original condition or better to the satisfaction of all permitting agencies, public works inspectors and supervising engineer.

Alternative 2 - Duke Energy Pipeline to ISO Van on MBARI Property
The HDD procedures for Alternative 2 the Duke Energy Pipeline to ISO Van on MBARI property include an estimated bore length of 1,014 feet (309 m) that would be installed an estimated depth of 30 feet (9 m) below the channel. An on-shore drilling crew, and construction monitors will support the HDD procedures. The onshore drilling crew will operate the drill rig, mud system (i.e. drilling fluid to lubricate the drill bit), and support equipment. During the drilling procedure, the monitoring vessel situated within the channel entrance will constantly monitor for surface releases of drilling mud, and maintain constant communication with the control cab during the entire HDD procedure.

Entry and exit points will be established, and relative elevations and drill distances surveyed in and verified, and a sub-bottom profile of the channel may need to be done to verify the proposed depth to install the cable are correct in order to establish a true running line and elevation for the drill path. The proposed 30 feet (9 m) depth to bury the conduit below the channel entrance should reduce the potential of drilling fluids being released to the surface.

The staging area for the HDD is within the same parcel identified in Alternative 1. However, the extra workspace area that will be used to set up the equipment; drill rig, mud system, support vehicles, and enclose the entry pit is 75 ft by 75 ft. The same erosion control structures and added protection measures used for Alternative 1 will be used for this alternative with the exception of the concrete pad to anchor the drill rig, which is not required for an HDD of this length.

The HDD procedures are similar to Alternative 1 with the exception of the exit location near the Duke Energy pipeline exposed on the north side of the channel.

A small pit will be dug for use as an exit location. The exit pit will hold the drilling mud, keeping it away from any sensitive areas, and allowing a convenient location for collection and disposal.

After successfully pulling the 2-inch conduit, a pull line will be blown through the conduit and tied off for use at a later date. The conduit ends will be capped and buried. In the event of an uncompleted bore hole, a pressure grouting method should be used to fill the void. By injecting a grout mix into the drill stem as it is being pulled out of the hole, the vacant cavity is filled.

Once the HDD procedures are complete excess drilling fluid will be removed from sump pit and disposed of at an regulatory approved disposal site. All plastic barriers and oil absorbent cloth will be removed and disposed of. Silt fence and hay bales will be removed. The work area will be returned to its original condition or better to the satisfaction of all permitting agencies, public works inspectors and supervising engineer.

Effects of the HDD procedures for both Alternatives include the potential for drilling muds (frac-out) to be released in an upland area (beach area) or within the bay. The accidental releases of drilling fluids could cause short-term degradation of surface water.

4 Required Permits

The list of permits required prior to project initiation are provided in Table 4-1.

Table 4-1 Required Permits for MARS Cable Project

Agency	Permit/Authorization/Consultation
Monterey Bay National Marine Sanctuary (MBNMS)	Special Use Permit
National Oceanic and Atmospheric Administration (NOAA)	National Environmental Policy Act (California Environmental Quality Act) Review
US Army Corps of Engineers	Nationwide 12 Permit (Section 10 of Rivers and Harbors Act and Section 404 of Clean Water Act)
US Fish and Wildlife Service	Letter of Concurrence (under Section 7, Endangered Species Act)
NOAA Fisheries - National Marine Fisheries Service	Letter of Concurrence (under Section 7, Endangered Species Act)
California State Lands Commission (CSLC)	Lease of State Lands
California Coastal Commission (CCC)	Coastal Development Permit Federal Consistency Certification
State Water Resources Control Board	National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activities
California Department of Fish & Game	Letter of Concurrence (under Section 7, Endangered Species Act)
California Department of Parks and Recreation (CDPR) Office of Historic Preservation	Consultation and Memorandum of Understanding (MOU) (under Section 106 of the National Historic Preservation Act)
Air Resources Board or Monterey Bay Unified Air Pollution Control District	Air Quality Authorization

Table 4-1 Required Permits for MARS Cable Project

Agency	Permit/Authorization/Consultation
Central Coast Regional Water Quality Control Board	Quality Certificate (under Section 401 of the CWA)
Northwest Information Center	Consultation and Historic Resources Update
Moss Landing Harbor District	Special Activities Use Permit or similar
Monterey County Planning and Building Department	Building Permit, if necessary

5

Proposed Schedule

The proposed schedule is to begin installation in the summer of 2005. The duration of each activity is noted below in Table 5-1.

Table 5-1 Proposed Schedule

Project Component	Duration
Project Preparations	5 weeks
Ile de Re Preparations	4 weeks
Ile de Re Main lay and burial	2 weeks
Horizontal Directional Drill	1-2 weeks
Shore-end works	1 week
Ile de Re Completion	2 weeks
Reporting	11 weeks

6 Collection of Supporting Offshore Field Data

A great deal of time has been spent reviewing data to select a route that accomplishes all the goals MBARI has set forth including: termination in an area of scientific interest, avoidance of restricted areas and obstructions, avoidance or minimization of impacts on sensitive natural resources and local communities, protection of the cable, and burial to the fullest extent possible along the entire cable route.

The overall purpose of the cable is to supply power and bandwidth to a scientific node, which will allow researchers to gather data from instruments in unprecedented volumes for extended periods of time. The site for this node was carefully selected. It is an area where science working-groups would like to establish time series instrumentation to further our understanding of poorly constrained oceanographic and geological processes. The node will be located at the end of the cable route. This location is on Smooth Ridge, a site important for scientific studies.

The proposed route has also been selected to avoid restricted areas and obstructions. Restricted areas include military zones (i.e. mainly navy and submarine exercise areas and firing range areas), protected areas such as marine sanctuaries or reserves, anchorage areas, and shipping lanes. Obstructions include buoys, rocks and shoals, wrecks, dumping areas, unexploded ordinance, and any other risks to a submarine cable.

To avoid or minimize impacts on sensitive natural resources, MBARI has chosen the most direct route possible while still achieving their goal to place the node in an area of scientific interest. This, coupled with burial, should assist in keeping impacts to a minimum. Burial will also serve to avoid conflicts with fisheries equipment and will help to protect the cable.

Additional factors were considered to protect the cable, including areas where burial difficulties may be encountered. Specifically, it will be problematic to bury cable due to substrate morphology along the entrance to Smooth Ridge. In areas where the route may encounter steep slope gradients, the route was designed to run as perpendicular as possible to slopes and to avoid possible areas of sediment slump or slides. Also, to allow better control during cable laying/burial operations, turns in the route are kept to a maximum of 10º.

6.1 Biological Surveys

In an effort to characterize benthic infaunal and epifaunal communities along the proposed Monterey Accelerated Research Program (MARS) cable route, MBARI conducted biological surveys in October 2003 through February 2004. During these surveys, Remotely Operated Vehicles (ROVs) were used to collect video data and sediment cores for studies of infaunal diversity and abundance. For this analysis, data from video and sediment samples collected was incorporated during a study of the former proposed MCI cable route that followed a portion of the MARS route. Generally, polychaete worms were the most abundant and species diverse group of infaunal organisms. Seapens were present on a large portion of the route, and were found in high density in many areas. Most of the fauna on the cable route are sedentary or functionally sedentary (i.e. very limited mobility). There are large numbers of suspension and filter feeders.

Methods

Shallow (23-573 m) areas of the 52.9 km-long MARS cable route were investigated with the MBARI *R/V Point Lobos* using the *ROV Ventana. Ventana* is equipped with a Sony HDC-750A high definition camera with HA10X5.2 Fujinon Zoom Lens. Deeper habitats (576-972 m) were surveyed with MBARI *R/V Western Flyer* using the *ROV Tiburon. Tiburon* is equipped with a Panasonic WVE550 3-chip camera. Lasers mounted on the ROVs were used to define the size of the area viewed in video images. Two lasers were mounted on the ROVs with beams parallel and spaced 30.5 cm apart. Over 38 hours of video was recorded using Sony Digital Betacam tapes as our recording media.

Additional surveys were conducted in 1999 from 47-450 m using the 100-foot vessel *Deanna Lee* equipped with a Phantom DS4 ROV. This portion of the survey line followed the former proposed MCI cable route (Towers 2003). Personnel from Oceaneering International, Inc. operated the ROV. The Phantom was equipped with a Benthos Model 387 35-mm camera and a Simrad Color Zoom Video camera model OE1366, and two lasers spaced 30 cm apart. The video feed from the Simrad camera was analog (composite); recordings were made to digital (miniDV) tape.

Specific sampling locations were chosen along the route to target representative depths (24, 44, 47, 640, 770, 795 and 885 m), and unique substrate and habitat types (e.g. sand, mud, hard substrates). Quantitative video transects and infaunal sampling was conducted at each of 11 pre-defined stations (Figure 2).